maxon motor

maxon motor control — ADS_E 50/5

Order number 166143

Operating Instructions — June 1999 edition

The ADS_E 50/5 is a powerful servo-amplifier for driving permanent magnet DC motors up to 250 Watts.

Four modes can be selected by DIP switches on the board:

- Speed control using tacho signals
- Speed control using encoder signals
- I x R compensated speed control
- Torque or current control

The ADS_E 50/5 is protected against excess current, excess temperature and short circuit on the motor winding.

With the FET power transistors incorporated in the servoamplifier, an efficiency of up to 95% is achieved.

A built in motor choke combined with the high PWM frequency of 50 kHz allows the connection of motors with a very low inductivity.
In most cases an external choke can be omitted.

Thanks to the wide input power supply range of 12 - 50 VDC, the ADS_E 50/5 is very versatile and can be used with various power supplies.
The Europa card size allows the unit to be installed in a 19“-subrack or in a plug-in card system. Thanks to the controller circuit design, the ADS_E 50/5 is easily and quickly installed.

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The latest edition of this operating instructions may also be found in the internet under http://www.maxonmotor.com («Downloads» in the category «Service & Support»).

1 Safety Instructions

Skilled Personnel
Installation and starting of the equipment shall only be performed by experienced, skilled personnel.

Statutory Regulations
The user must ensure that the servoamplifier and the components belonging to it are assembled and connected according to local statutory regulations.

Load Disconnected
For primary operation the motor should be free running, i.e. with the load disconnected.

Additional Safety Equipment
An electronic apparatus is not fail-safe in principle. Machines and apparatus must there-fore be fitted with independent monitoring and safety equipment. If the equipment breaks down, if it is operated incorrectly, if the control unit breaks down or if the cables break, etc., it must be ensured that the drive or the complete apparatus is kept in a safe operating mode.

Repairs
Repairs may be made by authorised personnel only or by the manufacturer. It is dangerous for the user to open the unit or make repairs to it.

Danger
Do ensure that during the installation of the ADS_E 50/5 no apparatus is connected to the electrical supply. After switching on, do not touch any live parts.

Max. Supply Voltage
Make sure that the supply voltage is between 12 and 50 VDC. Voltages higher than 50 VDC or of wrong polarity will destroy the unit.

Motor choke
The built in motor choke allows operation with almost all maxon DC motors with an output power higher than 10 Watt. For a few exeptions (A-max ∅26, 11W as well as RE ∅25 and RE ∅26 with terminal inductance lower than 0.35 mH) an extra inductance (choke) of at least 200 µH is necessary.

Electrostatic Sensitive Device (ESD)

2 Performance Data

2.1 Electrical data

Supply voltage Vcc (Ripple < 5%) ..... 12 - 50 VDC
Max. output current I_{max} ..... 10 A
Continuous output current I_{cont} ..... 5 A
Switching frequency ..... 50 kHz
Efficiency ..... 95 %
Band width current controller ..... 2.5 kHz
Built-in motor choke ..... 160 µH / 5 A

2.2 Inputs

Set value ..... -10 ... +10 V (R_i = 20 kΩ)
Enable ..... +4 ... +50 VDC (R_i = 15 kΩ)
Input voltage DC tacho ..... min. 2 VDC, max. 50 VDC (R_i = 14 kΩ)
Encoder signals ..... Encoder A, A\, B, B\, max. 100 kHz, TTL

2.3 Outputs

Current monitor „Monitor I“ , short-circuit protected ..... -10 ...+10 VDC (R_O = 10 kΩ)
Speed monitor „Monitor n“ , short-circuit protected ..... -10 ...+10 VDC (R_O = 10 kΩ)
Status reading „READY“
Open collector ..... max. 30 VDC (I_L < 20 mA)

2.4 Voltage outputs

Aux. voltage, short-circuit protected ..... +12 VDC, -12 VDC, max. 12 mA
Encoder supply voltage ..... +5 VDC, max. 80 mA

2.5 Trim potentiometers

I x R
Offset
n_{max}
I_{max}
gain

2.6 LED indicator

2 colors LED ..... READY /ERROR
green = READY, red = ERROR

2.7 Ambient temperature- / Humidity range

Operating ..... -10 ... +35 °C
Storage ..... -40 ... +85 °C
noncondensating ..... 20 ... 80 %

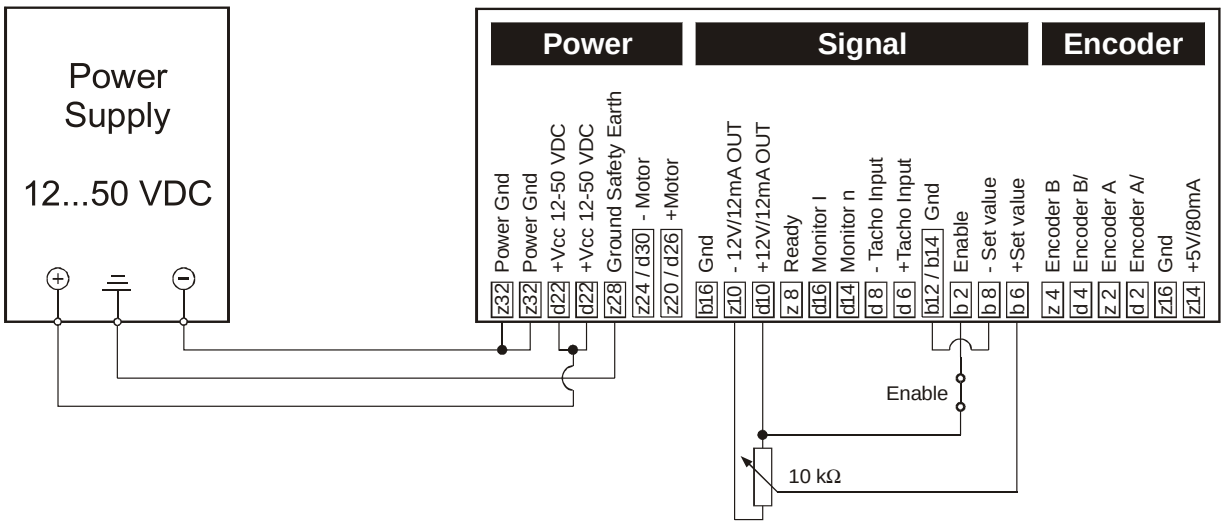
2.8 Mechanical data

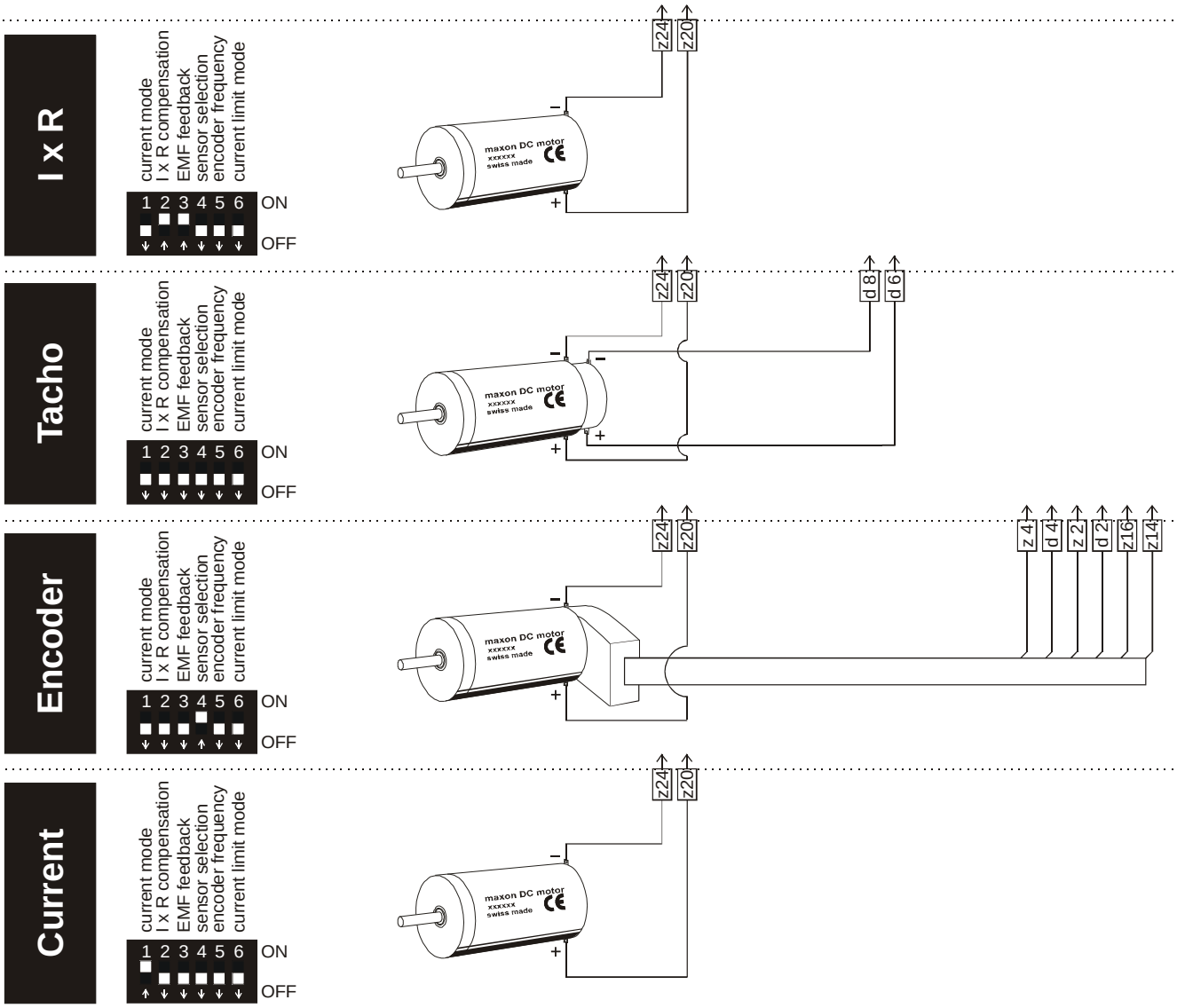
Weight ..... ca. 315 g
Dimensions ..... see dimension drawing

2.9 Terminal

Connector DIN 41612 ..... Version H7/F24

3 Minimum External Wiring for Different Modes of Operation





4 Operating Instructions

4.1 Determine power supply requirements

You may make use of any available power supply, as long as it meets the minimal requirements spelled out below.
During set up and adjustment phases, we recommend separating the motor mechanically from the machine to prevent damage due to uncontrolled motion.

Power supply requirements	
Output voltage	V_{cc} min. 12 VDC; max. 50 VDC
Ripple	< 5 %
Output current	5 A continuous (10 A peak)

The required voltage can be calculated as follows:
Known values:
- Operating torque M_B [mNm]
- Operating speed n_B [min^{-1}]
- Nominal motor voltage U_N [Volt]
- Motor no-load speed at U_N, n_0 [min^{-1}]
- Speed/torque gradient of the motor $\Delta n/\Delta M$ [min^{-1} mNm^{-1}]

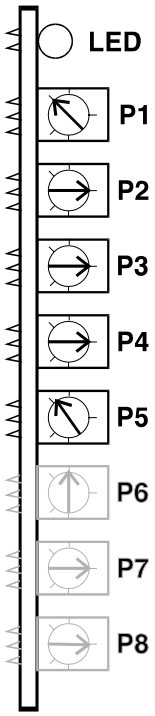
Sought values:
- Supply voltage V_{cc} [Volt]

Solution:

$$V_{cc} = \frac{U_N}{n_0} * (n_B + \frac{\Delta n}{\Delta M} * M_B) + 2\ [V]$$

Choose a power supply capable of supplying this calculated voltage under load.
The formula takes a 2 Volt max. voltage drop at the ADS_E 50/5 into account.

4.2 Function of the potentiometers

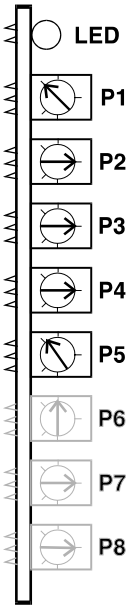


Potentiometer		Function	Turn to the left ↺	Turn to the right ↻
P1	I x R	I x R compensation	weak compensation	strong compensation
P2	Offset	Adjustment n=0 at set value 0V	motor turns CCW	motor turns CW
P3	n_{max}	max. speed at 10V set value	speed slower	speed faster
P4	I_{max}	current limit	lower min. 0.5 A	higher max. 10 A
P5	gain	amplification	lower	higher
P6		• For additional possible adjustments refer to chapter 6. • In use with the original frontplate, the potentiometers are covered !		
P7				
P8				

4.3 Adjustment of the Potentiometers

4.3.1 Pre-adjustment

With the pre-adjustment, the potentiometers are set in a preferred position. ADS_E units in original packing are already pre-adjusted.



Pre-adjustment		
P1	**I X R**	**0 %**
P2	**Offset**	**50 %**
P3	**n_{max}**	**50 %**
P4	**I_{max}**	**50 %**
P5	**gain**	**10 %**
P6	*n_{gain}*	*25 %*
P7	*I_{gain}*	*50 %*
P8	*I_{cont}*	*50 %*

Adjustment: refer to section 4.3.2

Additional possible adjustments: refer to section 6.1/6.2

4.3.2 Adjustment

Encoder mode
DC-Tacho mode
I x R compensation

1. Adjust set value to maximum (e.g. 10V) and turn potentiometer **P3 n_{max}** so far that the required speed is achieved.
2. Set potentiometer **P4 I_{max}** to the limiting value desired.
   Important: The limiting value I_{max} should be below the max. continuous current as shown on the motor data sheet.
3. Increase potentiometer **P5 gain** slowly until the amplification is set large enough.
   Caution: If the motor vibrates or becomes loud, the amplification is adjusted too high and the potentiometer must be readjusted until the instability of the closed loop of the drive under all loads disappears.
4. Adjust set value to zero, e.g. by short circuiting the set value input (link pins [b6] and [b8]). Then set the motor speed to zero with the potentiometer **P2 Offset**.

In addition, only in the case of IxR compensation:

5. Slowly increase potentiometer **P1 IxR** until the compensation is set large enough so that in the case of high motor load the motor speed remains the same or decreases only slightly.

Current controller mode

1. Set potentiometer **P4 I_{max}** at the limiting value desired.
   Important: The limiting value I_{max} should be below the max. continuous current as shown in the motor data sheet.

5 Functions

5.1 Inputs

5.1.1 Set value

The set value input is wired as a differential amplifier.

Input voltage range	-10...+10 V
Input resistance	20 kΩ
Positive set value	(+ set value [b6]) > (- set value [b8])
Negative set value	(+ set value [b6]) < (- set value [b8])

5.1.2 Enable

If a voltage is given at “Enable”, the servoamplifier switches the motor voltage to the winding connections. If the “Enable” input is not switched on or is connected to the Gnd, the power stage will be highly resistant and will be disabled.
The “Enable” input is short-circuit protected.

Enable	Minimum input voltage	+ 4,0 VDC
	Maximum input voltage	+ 50,0 VDC
	Input resistance	15 kΩ
	Switching time	typ 500 µsec (by 5 V)
Disable	Minimum input voltage	0 VDC
	Maximum input voltage	+ 2,5 VDC
	Input resistance	15 kΩ
	Switching time	typ 100 µsec (by 0 V)

5.1.3 DC Tacho

Minimum input voltage	2,0 V
Maximum input voltage	50,0 V
Input resistance	14 kΩ

The n_{max} potentiometer allows you to adjust the motor speed for a given set value input.
The lowest adjustable motor speed range is ±3850rpm with a ±10V set value and a tacho with 0.52V/1000rpm.
(3850rpm x 0.52V/1000rpm = 2V ; see table above)
Lower speed ranges can be achieved either by reducing the set value input range (i.e. ±5V for ±1925rpm) or using a tacho type with higher output voltage, such as 5V/1000rpm.

5.1.4 Encoder

Encoder supply voltage	+ 5 VDC max. 80 mA
Maximum encoder frequency	DIP - Switch 5 ON: 10 kHz DIP - Switch 5 OFF: 100 kHz
Voltage value	TTL low max. 0,8 V high min. 2,0 V

It is strongly recommended that the encoder be used with a built-in line driver. If the encoder is used **without** a line driver (without EncoderA\ and EncoderB\), speed breakdowns and max. speed limits must be expected because of the slower switching slope.

The servoamplifier does not need any home impulse I and I\.

5.2 Outputs

5.2.1 Current monitor „Monitor I“

The servoamplifier makes a current actual value available for monitoring purposes. The signal is proportional to the motor current.
The „Monitor I“ output is short-circuit protected.

Output voltage range	-10... +10 VDC
Output resistance	10 kΩ
Gradient	approx. 0,8 V / A

5.2.2 Speed monitor „Monitor n“

The speed monitor is primarily intended for the qualitative estimation of the dynamics. The absolute speed is determined by the properties of the speed sensors and by the setting of the n_{max} potentiometer. The output voltage of the speed monitor is proportional to the number of revolutions. The output voltage of the speed monitor is 10V when the maximum number of revolutions set by the n_{max} potentiometer has been reached.
The “Monitor n” output is short-circuit protected.

Output voltage range	-10... +10 VDC
Output resistance	10 kΩ

5.2.3 Status reading „Ready“

The “Ready“ signal can be used to report the state of operational readiness or a fault condition on a master control unit. The „Open Collector“ output is, in normal cases, i.e. no faults, switched to Gnd. In the case of a fault due to excess temperature or excess current, the output transistor is not conducting (high resistance).

An external additional voltage is required:

Input voltage range	max. 30 VDC
Load current	< 20 mA

The fault condition is stored. In order to reset the fault condition, the servoamplifier must be re-released (Enable). If the cause of the fault situation cannot be removed, the output transistor will immediately change to the not conducting state again.

6 Additional Possible Adjustments

Potentiometer		Function	Position left ↺	Position right ↻
P6	n_{gain}	speed gain	low	high
P7	I_{gain}	current gain	low	high
P8	I_{cont}	continuous current limit	lower	higher

6.1 Adjustments potentiometer P6 n_{gain} and potentiometer P7 I_{gain}

In most applications, regulation setting is completely satisfactory using potentiometers P1 to P5. In special cases the transient response can be optimized by setting the P6 “speed regulation gain” potentiometer. The P7 “current regulator gain” potentiometer can, in addition, be adapted to the dynamics of the current regulator.
It is recommend that the success of changes to the settings of P6 n_{gain} and P7 I_{gain} be checked by measuring the transient response with an oscilloscope at the “Monitor n” and “Monitor I” outputs.

Pre-adjustment P6 n_{gain} = 25 % and P7 I_{gain} = 50 %.

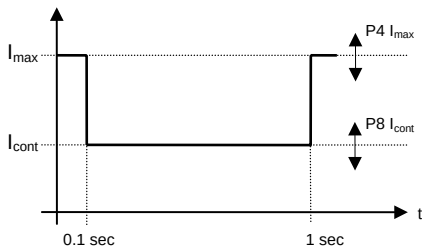
6.2 Adjustments potentiometer P8 I_{cont} and current limit mode DIP-Switch 6

It is standard that a maximum current limiter is activated (DIP switch 6 OFF) as the only current limiter. In this way the motor current is limited to the value set on potentiometer P4 I_{max} (0.5 ... 10A).
If DIP switch 6 is turned to ON, a cyclical current limiter is also activated. This current limiter method makes a certain level of motor protection against thermal overload possible.
For 0.1 seconds the motor current is limited to the value set on potentiometer P4 I_{max} (0.5 - 10A) and then for 0.9 seconds current is limited to the value set on potentiometer P8 I_{cont} (0.5 - 10A). After one second a current of I_{max} is allowed.

Pre-adjustment P8 I_{cont} = 50%.

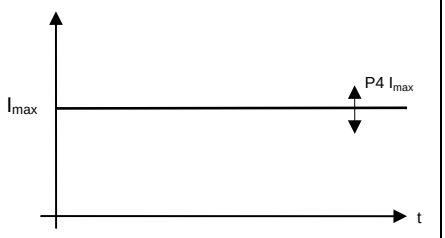
DIP-Switch 6 ON ↑

cyclical current limiter active



DIP-Switch 6 OFF ↓

maximum current limit active



6.3 Maximal encoder frequency DIP-Switch 5

DIP switch 5 permits selection of the maximum encoder input frequency.
A max. encoder frequency of 100 kHz is standard.

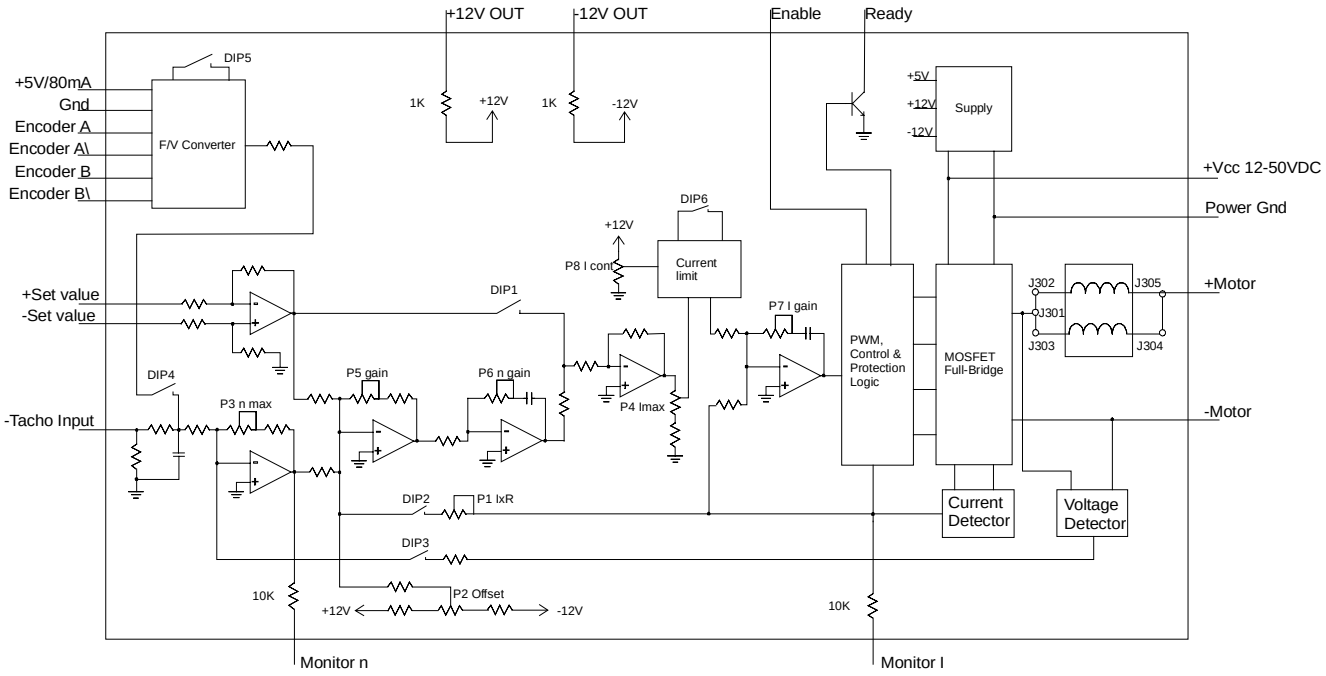
DIP-Switch 5 ON ↑	
Max. Input frequency is 10 kHz	
Encoder pulse per turn	maximum motor speed
100	6'000 rpm
500	1'200 rpm
1000	600 rpm

DIP-Switch 5 OFF ↓	
Max. Input frequency is 100 kHz	
Encoder pulse per turn	maximum motor speed
100	60'000 rpm
500	12'000 rpm
1000	6'000 rpm

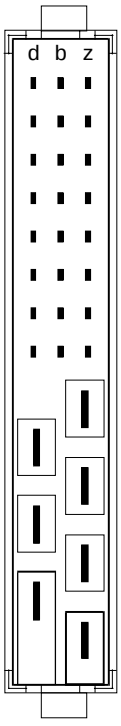
7 Error Handling

Defect	Possible source of defect	Measures
Shaft does not rotate	Supply voltage < 12 VDC	check power plug pin [d22]
	Enable not activated	check signal plug pin [b2]
	Set value is 0V	check signal plug pin [b6] and pin [b8]
	Current limit too low	check adjustment pot. P4 I_{max}
	Wrong operational mode	check DIP switch settings
	Bad contacts	check wiring
	Wrong wiring	check wiring
Speed is not controlled	Encoder mode: encoder signals	check encoder signal
	DC- Tacho mode: tacho signals	check pin [d6] and [d8] (polarity)
	I x R mode: compensation wrong	check adjustment pot. P1 I x R

8 Block Circuit Diagram



9 Pin Allocation Connector DIN 41612 Version H7/F24

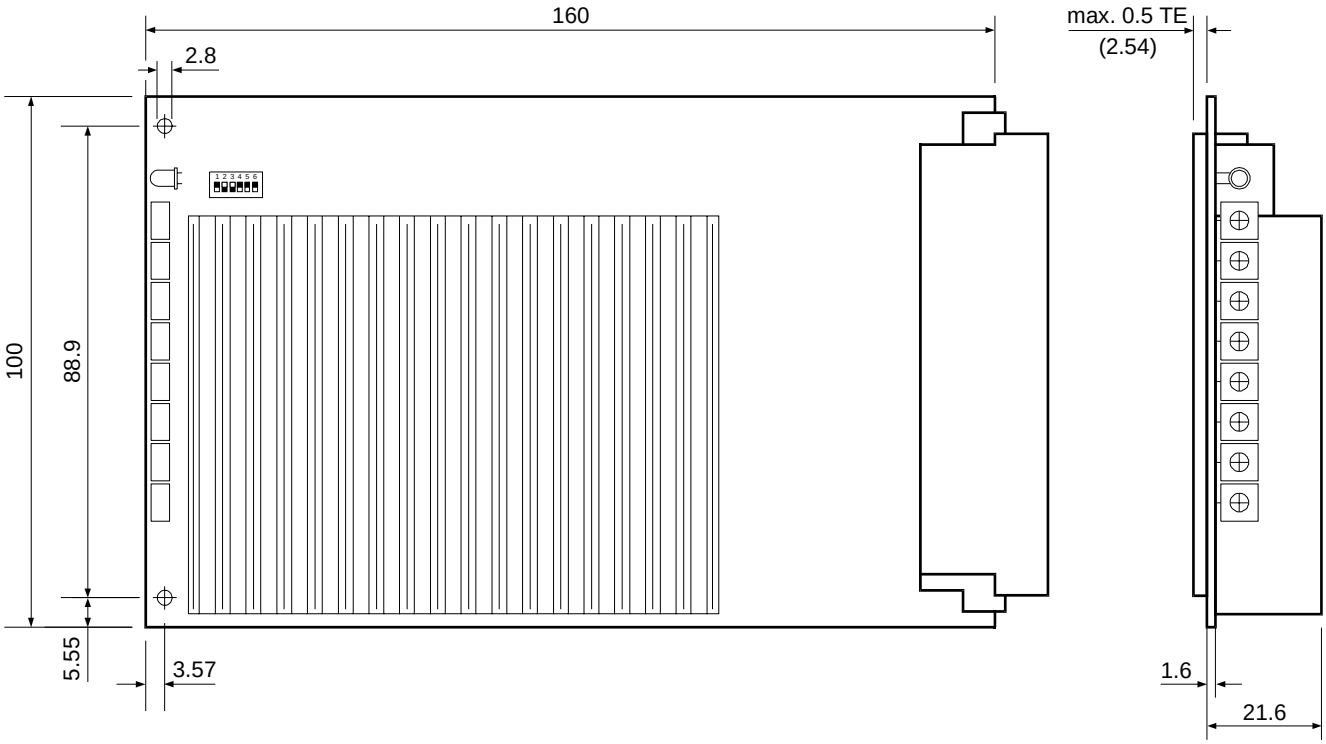


	d	b	z
2	Encoder A\	Enable	Encoder A
4	Encoder B\	n.c.	Encoder B
6	+ Tacho Input	+ Set value	n.c.
8	- Tacho Input	- Set value	Ready
10	+12V/12mA OUT	n.c.	-12V/12mA OUT
12	n.c.	Gnd	n.c.
14	Monitor n	Gnd	+ 5V/80mA
16	Monitor I	Gnd	Gnd

20	+ Motor	
22	+Vcc 12-50VDC	
24	- Motor	
26	+ Motor	
28	Ground Safety Earth	
30	- Motor	
32	Power Gnd	

10 Dimension Drawing

Dimensions in [mm]

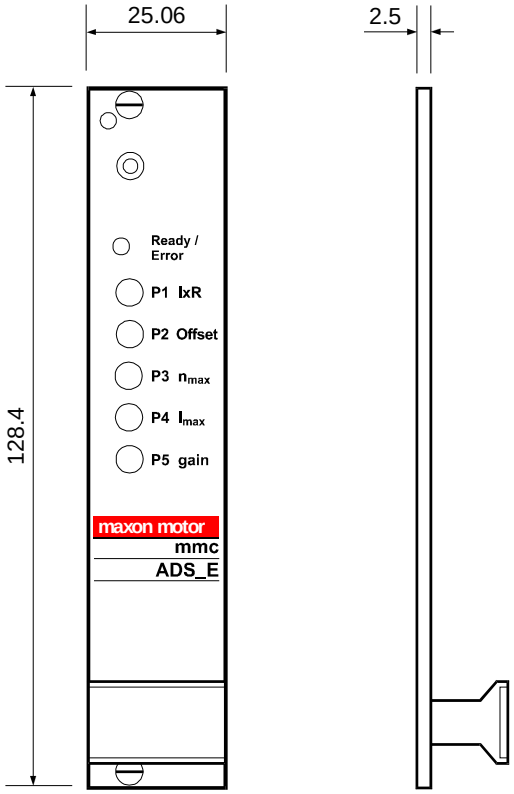


11 Accessories (not part of delivery)

11.1 Front panel: Order number 167850

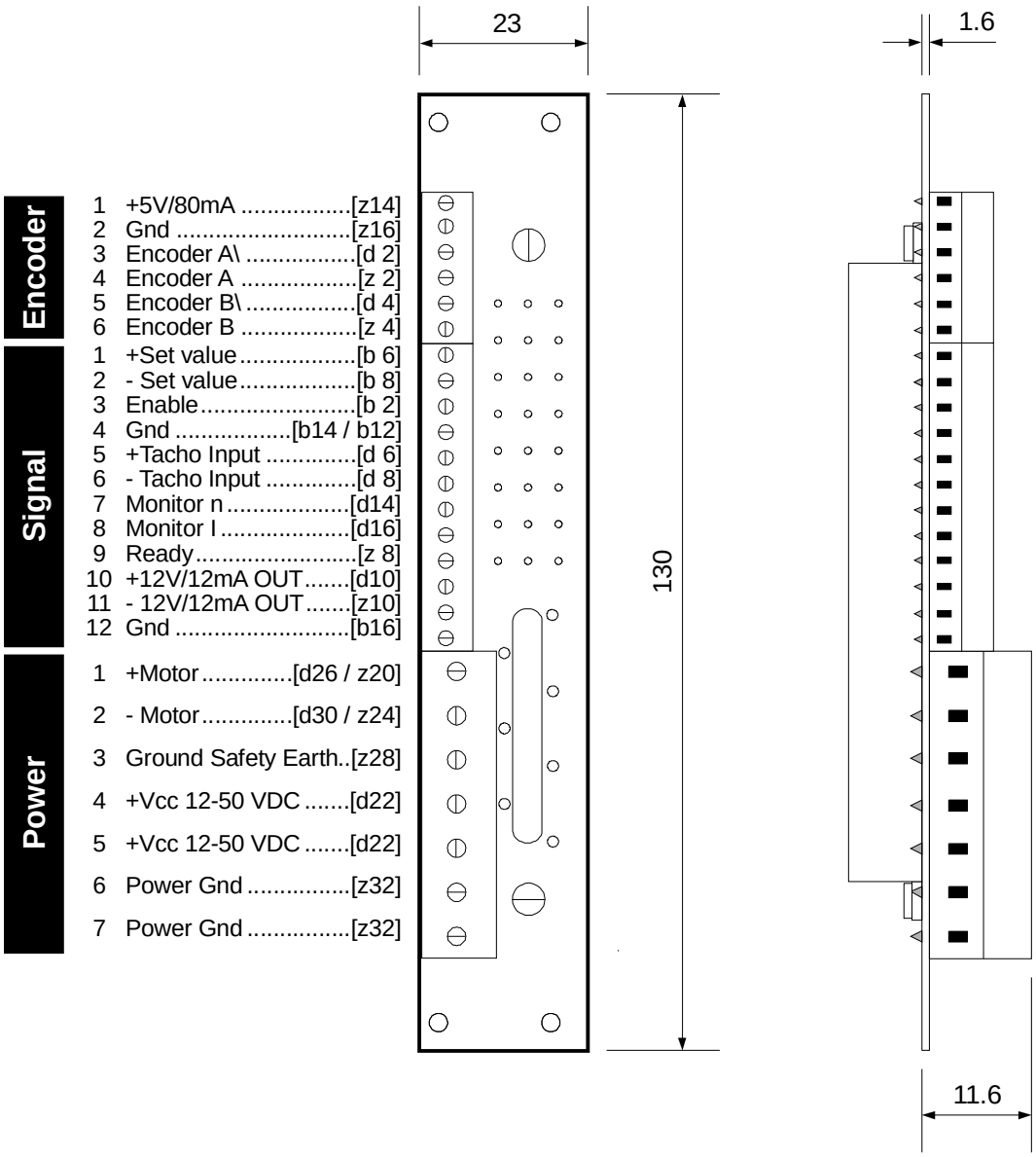
Dimensions in [mm]

clear anodised
5 TE, 3 HE



11.2 Backplane with screw terminals: Order number 166873

Dimensions in [mm]



	No. of poles	Pitch	suitable for wire cross section
Encoder	6	3.81 [mm]	0.14 - 1.5 [mm^2] (single wire) 0.10 - 1.0 [mm^2] (multiple-stranded wire)
Signal	12	3.81 [mm]	0.14 - 1.5 [mm^2] (single wire) 0.10 - 1.0 [mm^2] (multiple-stranded wire)
Power	7	5.08 [mm]	0.14 - 1.5 [mm^2] (single wire) 0.14 - 1.5 [mm^2] (multiple-stranded wire)